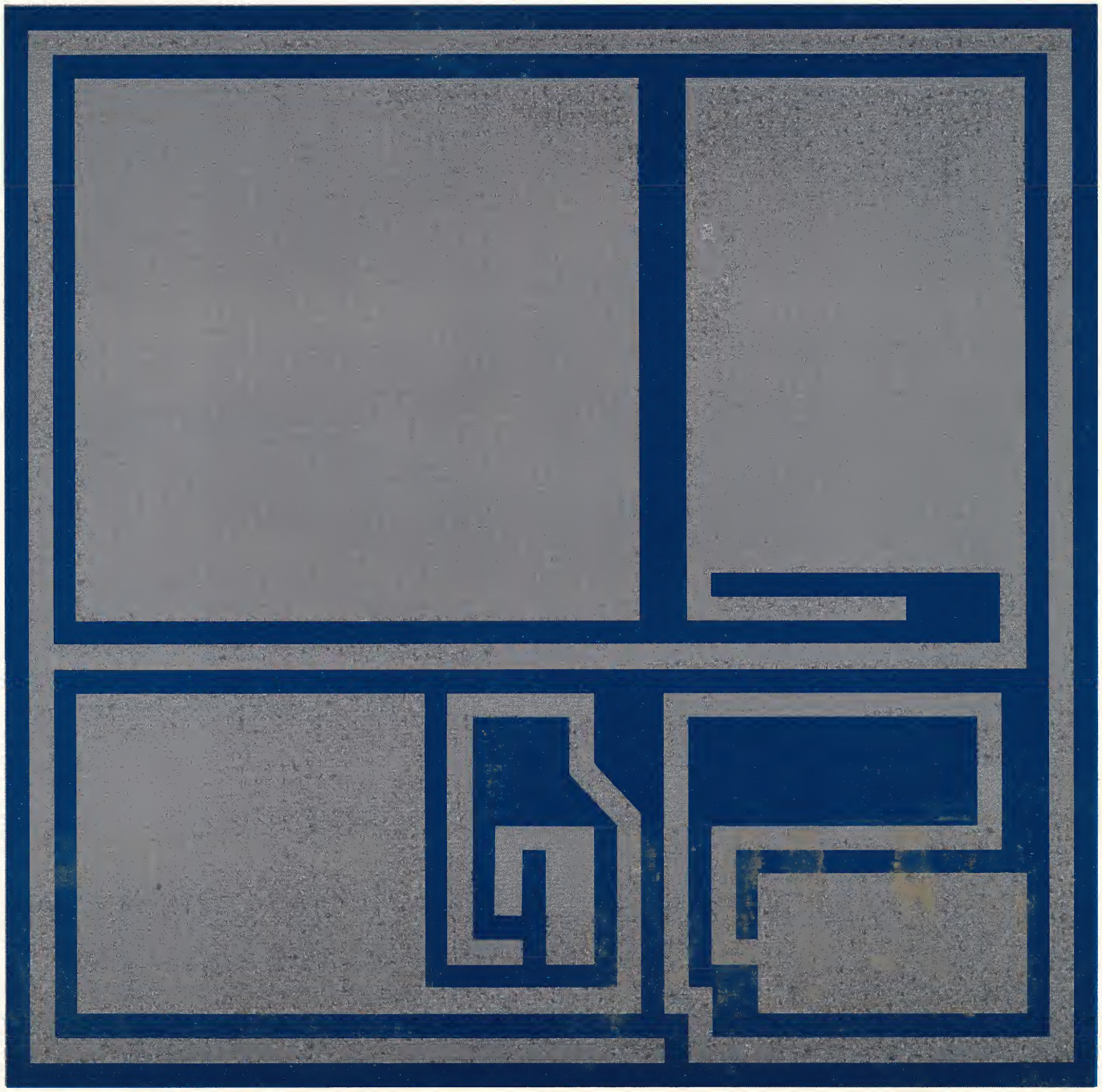
INTEGRATED CIRCUIT APPLICATIONS BY MOTOROLA'S MILITARY ELECTRONICS DIVISION



The Motorola Military Electronics Division is a world leader in the exploration of advanced applications of the integrated electronics technology to the design of military and space equipment. Integrated electronics offers vastly improved reliability, substantial reduction in size, weight, and power consumption, easier maintenance and in many instances lower manufacturing cost. Presented in this booklet are some of the more recent typical applications.

For further, more detailed information, write or call our Headquarters office *8201 E. McDowell Rd., Scottsdale, Ariz. 85252 Phone: Area 602/947-8111* or any of the offices listed below.

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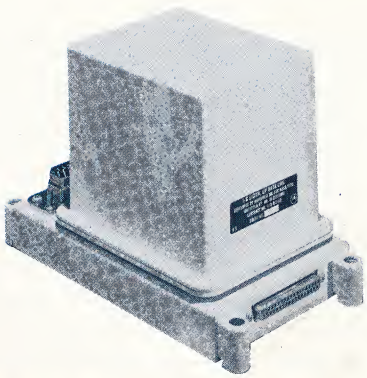
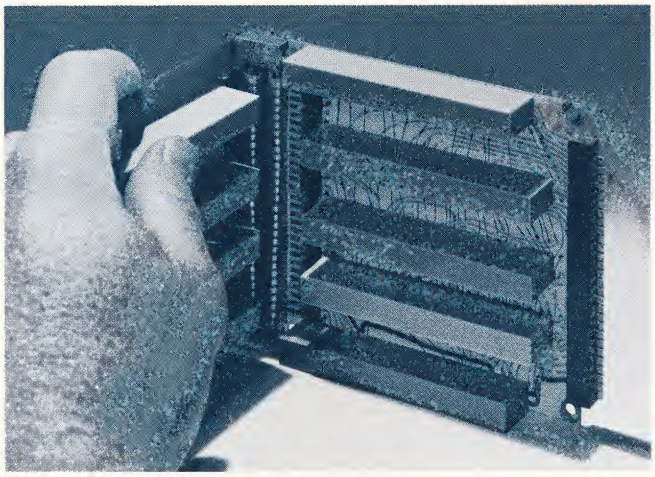
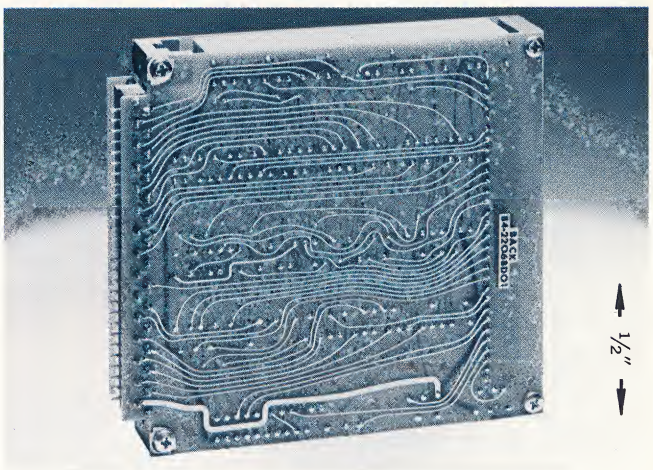
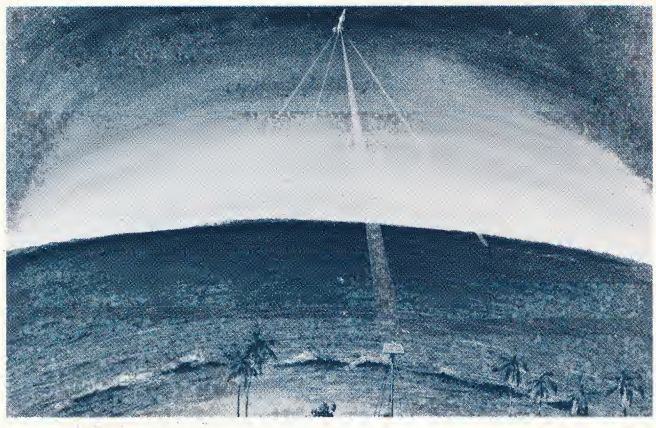
NASA UP-DATA LINK

For NASA's Manned Spacecraft Center, Motorola is building a microcircuit version of the Apollo spacecraft's up-data link. The prime objectives of this program are to reduce size and weight. Using integrated circuits and high-density packaging techniques, we have halved its size and cut its weight by nearly two-thirds. Motorola is also building the original solid state Apollo up-data link. The new I/C unit is proposed for use in Apollo Block II missions.







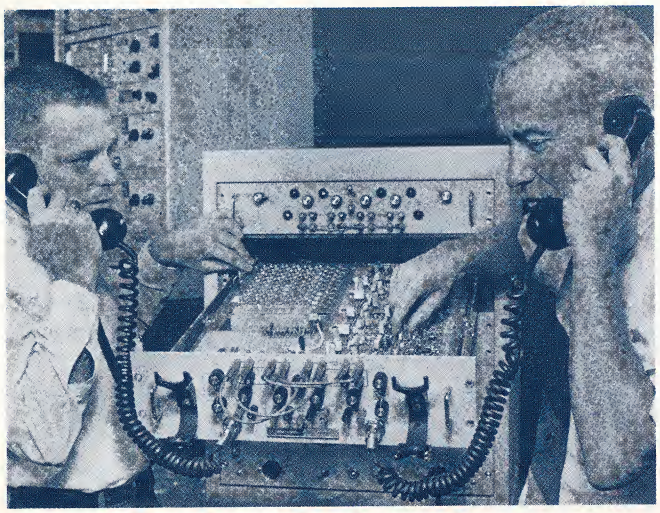


AROD

This is an Airborne Range and Orbit Determination (AROD) system that we are developing for NASA/Marshall SFC. It's a new NASA concept, made practical by integrated circuits, that puts the relatively complex equipment in the spacecraft and the usually vehicle-mounted transponder on the ground. This facilitates the collection of data onboard the vehicle in near real time; thus, permitting use of AROD for navigation purposes or vehicle evaluation. Integrated circuits and high-density packaging techniques will be used extensively to keep the space-borne equipment within payload limitations.

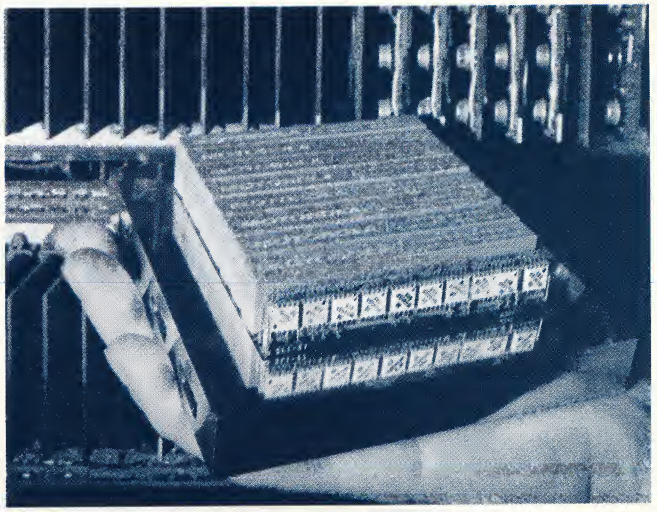
APOLLO CHECKOUT EQUIPMENT

Under contract to North American Aviation, Inc., Motorola is building a Digital Test Command System (DTCS) for the Apollo spacecraft. Because of the complexity of the logic of this system, integrated circuits proved to have a cost advantage over discrete circuitry. Integrated circuits also contribute to a significant reduction in size and weight, which are prime considerations for the system. This program is expected to use approximately 200,000 Motorola MECL logic circuits. DTCS is part of a new concept of prelaunch Acceptance Checkout Equipment which is designed using advanced technology to provide vastly improved reliability assurance for missiles and spacecraft.



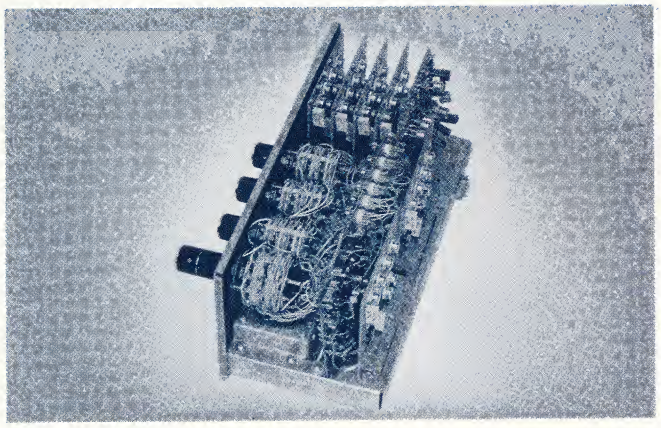
DELTAPLEX COMMUNICATIONS

Under an Air Force program, Motorola has developed a digital multiplex communications system (Deltaplex). The digital sections are implemented with DTL integrated circuits. This equipment has been installed and tested on the 370-mile troposcatter link between Puerto Rico and Grand Turk Islands. Results of the test were excellent demonstrating the feasibility of the approach and the efficacy of integrated circuits.



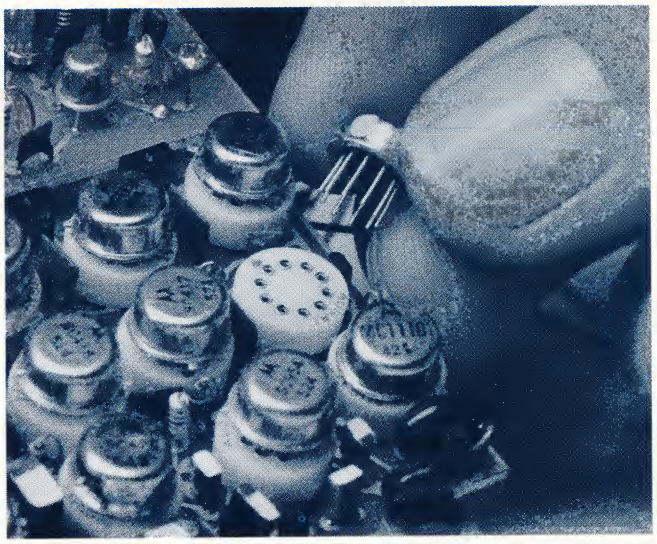
DIGICOM

For the Air Force at Dayton, we developed an integrated circuit, digital communications system (DIGICOM). This is a four-channel communications system that utilizes approximately 100 analog and 200 digital integrated circuits. DIGICOM includes the premodulation section of the transmitting terminal and the post-demodulation section of the receiver terminal. Voice is digitized with a resolution of 7 binary bits at a conversion rate of 30 Kc.



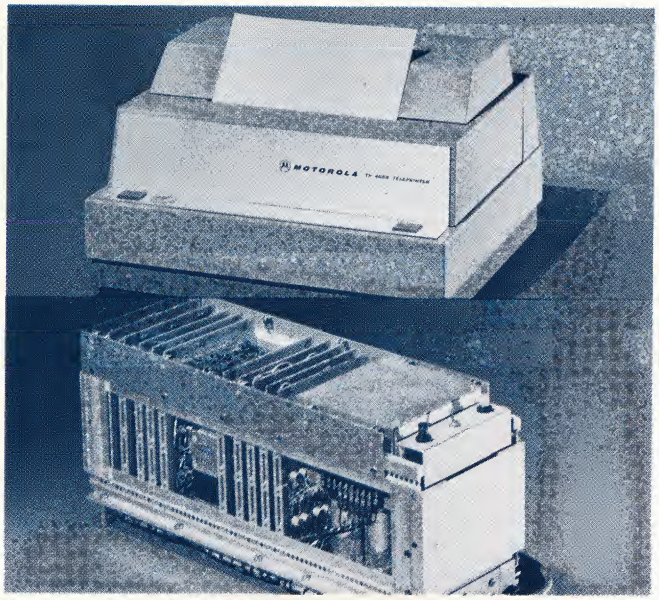
FREQUENCY SYNTHESIZER

Here, digital integrated circuits are applied to provide 8000 channels, with 5 Kc spacing, in the 30-70 Mc frequency range. This integrated circuit frequency synthesizer is applicable in multiple-channel communications equipment such as Radio Central. The synthesizer employs a voltage controlled oscillator and a high-speed counter that are implemented with Motorola MECL circuits. In addition to the inherent size, weight, and reliability merits of integrated circuits, the use of standard digital logic blocks simplifies circuitry and eliminates alignment problems associated with analog synthesizers.



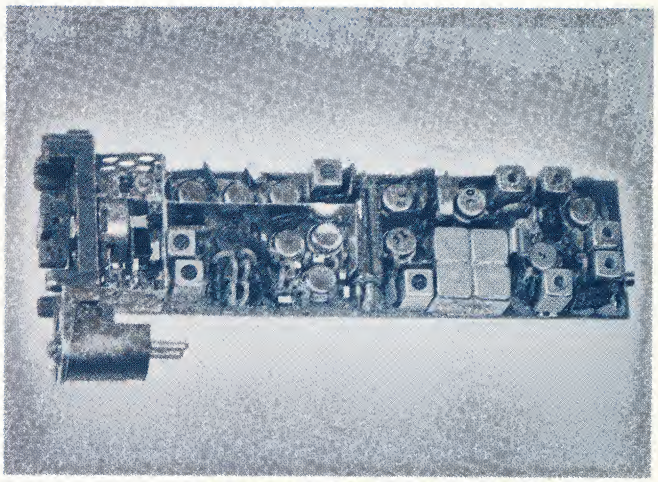
FM TRANSCEIVER

Now in development is an integrated circuit FM transceiver directed toward filling the next-generation tactical communications needs. Criteria for this equipment in descending order are: performance, cost, and size. In keeping with the integrated electronic concept, this equipment will be implemented with all electronic tuning; thereby, eliminating the need for shafts, gears, and other mechanical devices.



TP-4000 TELEPRINTER

Integrated circuits are used in the translator section of our advanced, low-cost, compact TP-4000 teleprinter. The use of microcircuits contributed to reducing the size and cost of this efficient teleprinter that is specifically designed to serve in high-speed data processing systems.



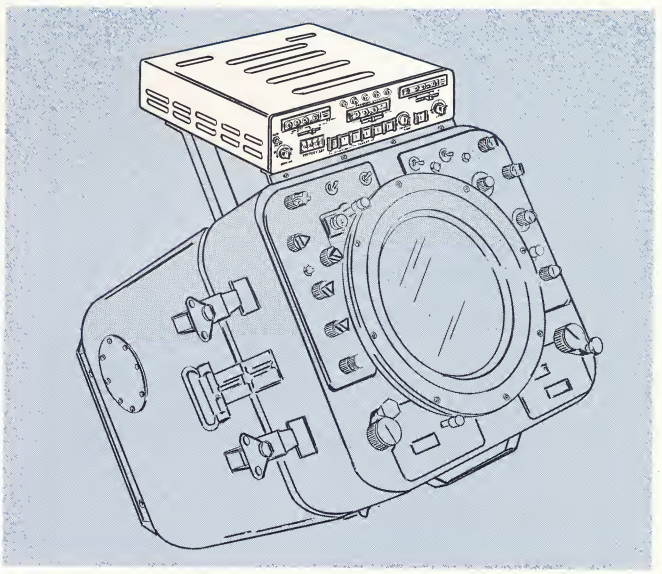
PERSONAL RADIO

We have developed small-signal integrated circuits for a miniature, light-weight personal radio receiver suitable for use as a helmet radio. In addition to the miniaturization and weight reduction advantages, the new integrated circuit version performs better in all respects over the original solid state personal receiver; moreover, power consumption is substantially reduced. Monolithic, compatible thin-film/monolithic and hybrid techniques are applied to construct the various types of circuits required.

ULTRA-RELIABLE UHF TRANSCEIVER

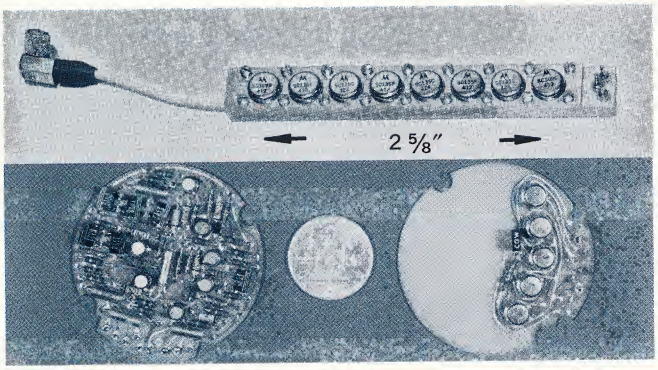
Recently designed for the Office of Naval Research, under contract NOnr 4179(00), this six-channel UHF transceiver has proven the feasibility of using integrated circuits and redundancy techniques to enhance the reliability of communications equipment.

In this program, four integrated circuit techniques were employed—hybrid, thin-film, monolithic and combined monolithic/thin-film. Fourteen different types of integrated circuits were used, many of them being developed by Motorola for this application. For complete details on this Ultra-Reliable UHF transceiver, request "Redundant IC's Boost Transceiver Reliability".



RADAR INTERCEPT CALCULATOR

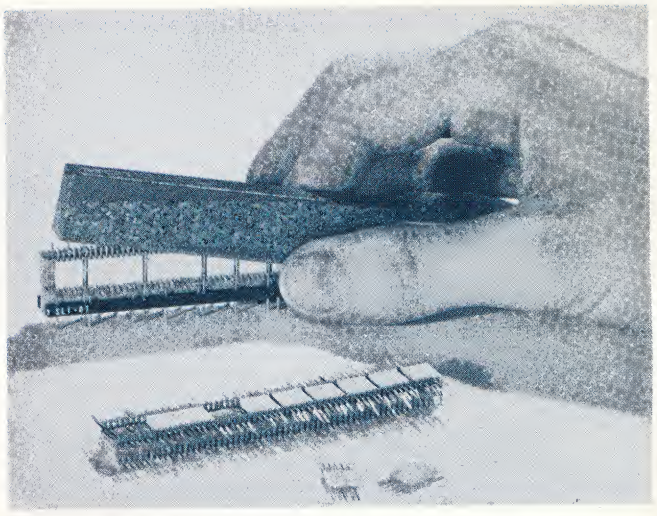
For Rome Air Development Center, we are engaged in a development program to produce a Radar Intercept Calculator to provide semi-automatic target tracking and intercept prediction capability. This device, which mounts on a PPI scope will utilize 2,200 DTL integrated circuits and will be packaged in a "black box" measuring 12 x 12 x 5 inches.



TRANSPONDERS*

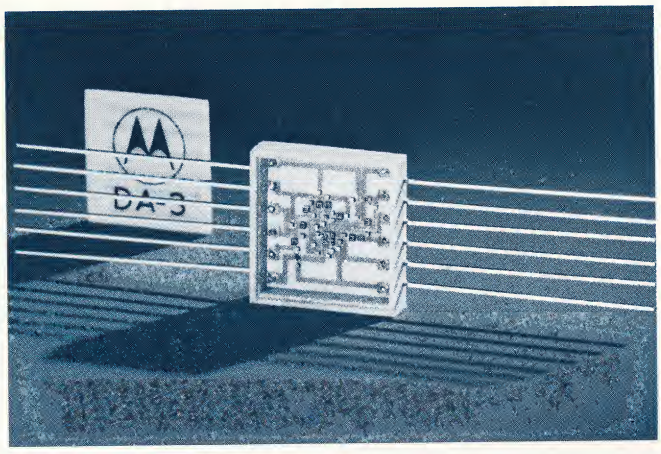
Both analog and digital integrated circuits have been developed for the Motorola transponder product line. All the attributes of integrated circuits are particularly applicable to the transponder and other space hardware. The integrated 60 Mc i-f amplifier (top portion of illustration) developed for our radar transponders occupies only 0.5 cubic inch and weighs 0.7 ounce. Also shown, is a comparison of the integrated circuit decoder and the original decoder. And where I/C techniques are not presently applicable we have applied other integration techniques to miniaturize these parts. For example, the preselector cavities and mixer are fabricated from a single homogenous block.

*Write for Engineering Bulletin Vol. 13, No. 2 with complete I/C story



PACKAGING TECHNIQUES

Packaging techniques are a prime consideration in designing and developing integrated circuit equipment. Motorola developed a packaging technique called micro-harness to gain the advantages of volumetric efficiency and maintainability offered by integrated circuits. We have also evaluated many other packaging techniques utilizing both TO-5 and flat packs from the density, reliability, cost, interconnection, and other viewpoints.



MULTI-PURPOSE MONOLITHIC CHIPS

Integrating analog systems is still beset by the virtual nonexistance of off-the-shelf integrated linear circuits and the high-cost and long development cycle of customized circuits. To obviate this condition, we have developed multi-purpose monolithic chips that can be used in conjunction with thin-film and semiconductor components to quickly fabricate several different types of linear circuits, such as the differential amplifier shown above. This approach will permit integrated circuits to satisfy a greater number of analog functions in military and space equipment.

OTHER TYPICAL I/C APPLICATIONS

ONE-WAY DATA LINK FOR AIRCRAFT LANDING SYSTEMS: Developed integrated circuits for receiver, decoder, frequency synthesizer and new packaging techniques.

RANGE GATED FILTER: Designed for man-packed battlefield surveillance radars. Introduction of monolithic techniques to this filter has cut its size by four-fifths and reduced weight by two-thirds. The integrated circuitry is contained in a single flat pack that consists of 27 transistors and 38 diodes.

SPACE-GROUND LINK SYSTEM (SGLS): The Digital Ranging System in the SGLS features Motorola MECL logic circuits for improved reliability, size reduction and maintainability.

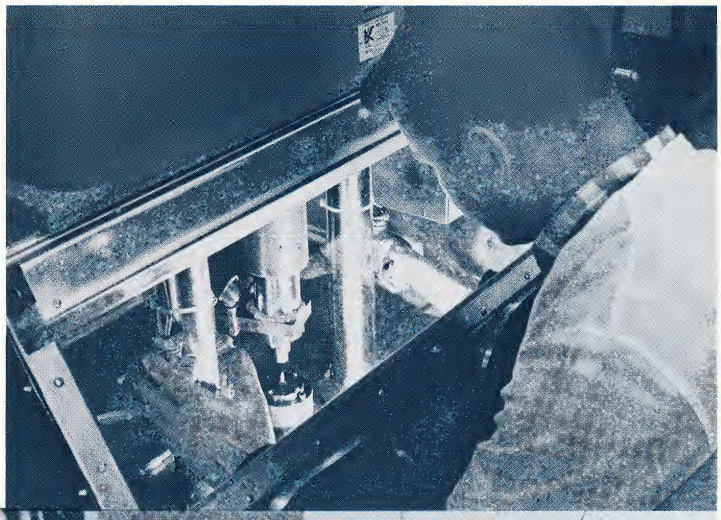
FUZING AND GUIDANCE APPLICATIONS: Integrated circuits have been applied to range measurement fuzes, altitude measurement proximity fuzes, and missile guidance equipment.

INTEGRATED ANTENNAS: Various antenna types have been built that include the RF stages as an integral part of the antenna structure. Integrated antennas provide significantly increased performance and reliability, and they also contribute to a considerable size and weight reduction.

PROTOTYPE INTEGRATED CIRCUIT FACILITY

In addition to being close to the Motorola Semiconductor Products Division, the Military Electronics Division has its own in-house prototype integrated circuit facility. This facility maintains a stock of semiconductor and thin-film components which can be quickly breadboarded to test various types of integrated circuits. Moreover, it provides our engineers with the versatility of being able to combine semiconductor and thin-film techniques.

A. Vacuum evaporator for thin film deposition
B. Bonding semiconductor components to a header
C. Hermetically sealing integrated circuit packages
D. Wire and die bonders
E. Vacuum evaporator for R & D thin film functions



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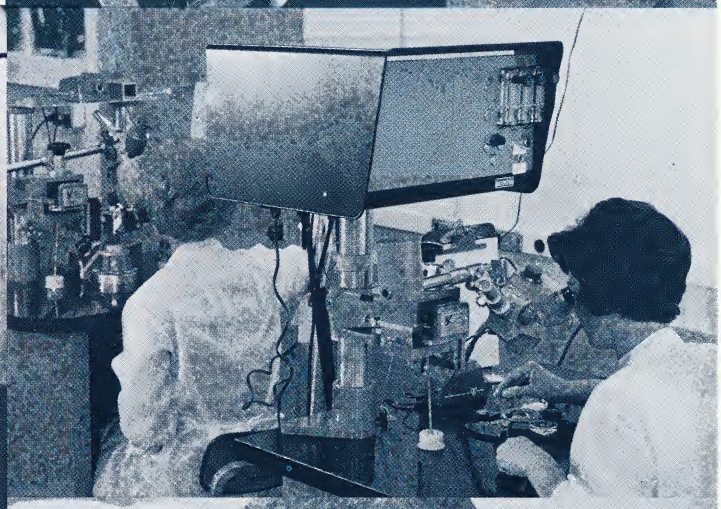

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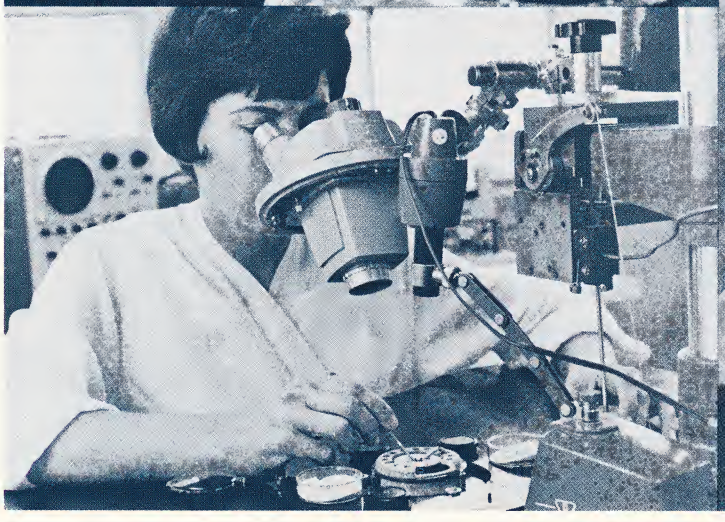

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